Spring 2022 EE214 Project Work
Final Report

Ahmet Akman 2442366
Yusuf Toprak Yıldıran 2444149

1 Introduction

In this document we present our work done to satisfy the requirements of the Term Project of EE214 laboratory course. Accord,ng to the project description we are supposed to make a transmitter which produces different frequency tones (pure sinusoids) and collect them together, and a receiver which can be tuned to these frequencies. The received tone will be played with a speaker. So, in order to overcome the challange of generating sinusoids with needed frequencies the square wave generator circuits are used. In the receiver unit , the bandpass filter with topology called dual-opamp is used as planned in the Preliminary Report. For the speaker unit a simple opamp amplifier is utilized.

2 Transmitter Unit

3 Receiver Unit

In the receiver unit design phase the design path described in the Preliminary report is followed. The reference point for the filter design was primarily the analog filter design guide prepared by Analog Devices company.

3.1 Dual-Opamp Topology

The reason why the dual-opamp bandpass filter is used is there are only two resistors which adjust the frequency and fixing the value of the one is acceptable. Also the quality factor can be adjusted almost independent from the resonant frequency. The transfer function of this topology can be expressed as;

$$\frac{H\omega_0^2}{s^2+\alpha\omega_0 s+\omega_0^2}$$

The general schematic of the topology is given in Figure X .

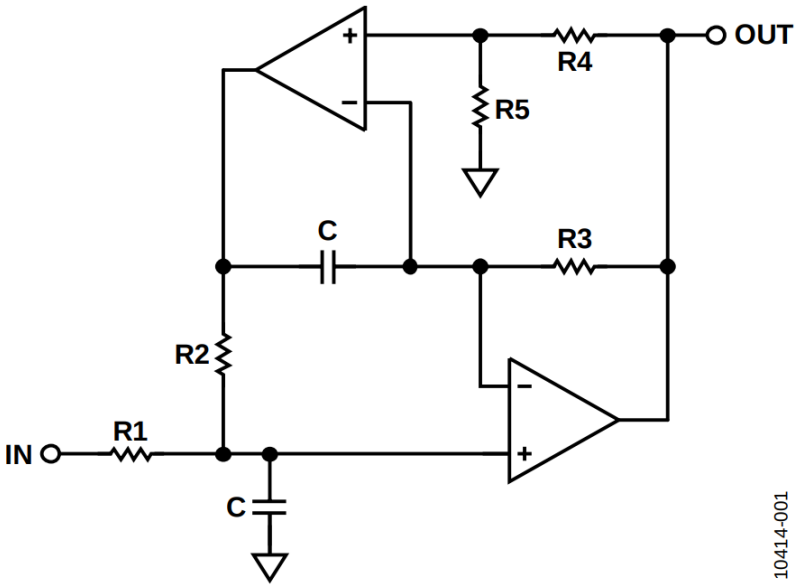

Figure 1: Dual-opamp topology schematic

3.2 Compononent Selection and Simulation Results

To be able to adapt the circuit efficiently to our purpose following goals are set. The design tables for the standard responses are not used to freely choose the component values. Instead the responses are obtained through multiple simulations.

- The values of the passive components should be easy to supply.
- The R3 should be fixed so that the highest Q obtained for 14-15 kHz frequencies , since harmonics of the transmitter signal are quite small compared to the 1 and 2 kHz.

So the values of R4 and R5 are fixed to 1k and R1 is fixed to 100K. The capacitors are fixed to 10nF. Then series of simulations are made to find suitable value for R3 and it is fixed to 1K for better amplification of 14-15 kHz signals. Lastly the values of the R2 is fine tuned for every frequency. This is also important to determine which range of potentiometers to be used. The frequency response for the receiver circuit obtained in LTSpice is given in Figure X.

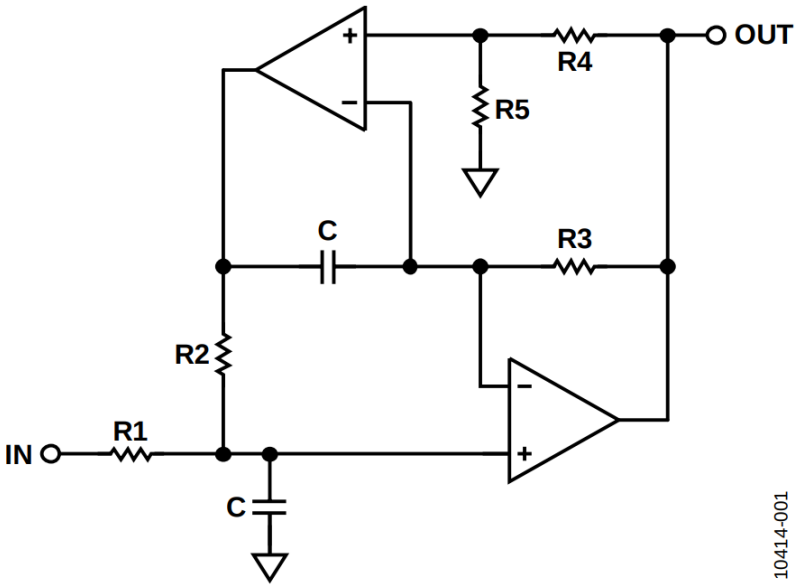

Figure 2: Receiver circuit frequency response.

4 Physical Prototype and Results

To be able to contruct the designed circuit LM358 (datasheet an ic packaged two opamp) is used. To ensure an average two opamp ic is sufficient to accomplish the needed filtering double opamp ic's with same pinout TL072 and TL082 are tested and obtained the same result. The physically prototyped version of the circuit is given in Figure X.

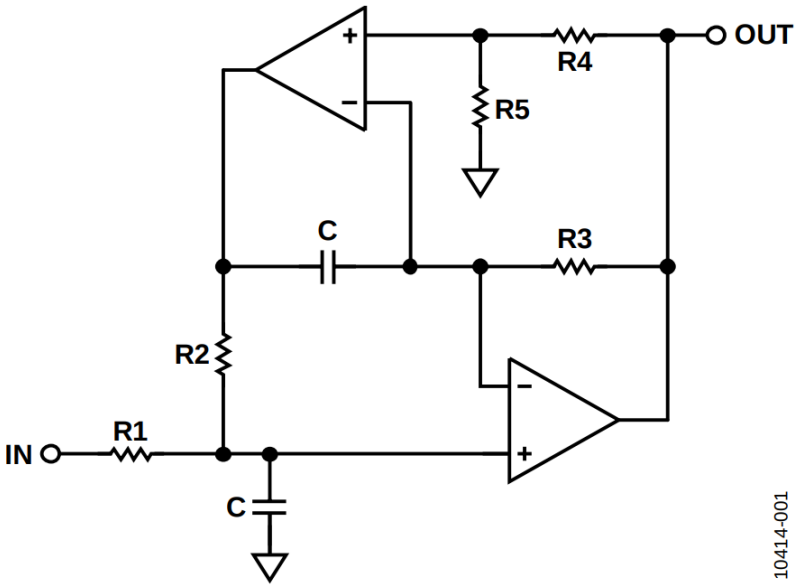

Figure 3: Receiver Unit Breadboard

Four potentiometers with 1K 10K 50K and 250K are used in series for R2 to fine tune the middle frequencies. So the one potentiometer bonus is achieved. As a result an analog bandpass filter with adjustable middle frequency is obtained succesfully. The filter is able to filter all needed signals accurately with approximately 30-40 dB difference. The output amplitude of the filter is ranging from 6 Vpp to 2Vpp.

5 Speaker Unit

For the speaker unit a simple approach is followed. Since the transmitter has decreasing harmonics amplitude and the receiver has incresing gain for increasing frequencies, the speaker amplification need not to be higher than 2X. Also a headphone speaker with 32R impedance is used which has not need for high current flow. As a result an inverting opamp amplifier is used. The schematic is given in Figure X.

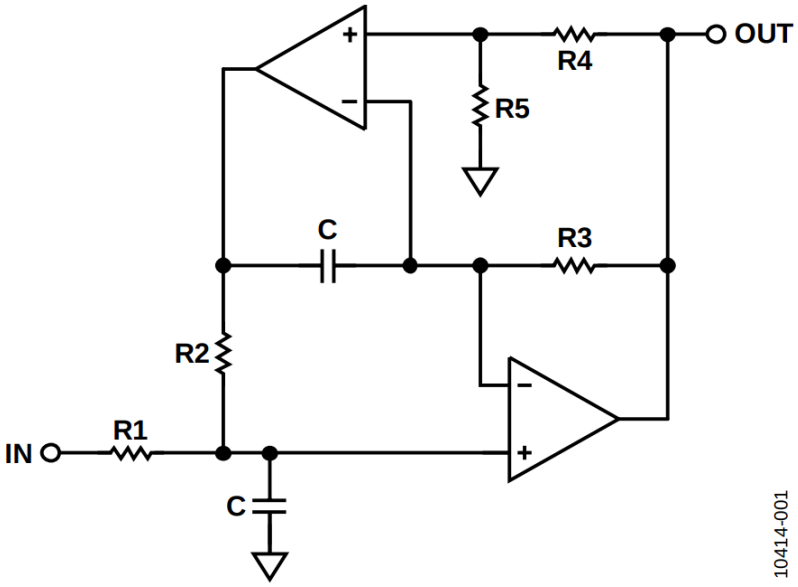

Figure 4: Speaker unit schematic

As a result all needed signals are quite audible with (almost) sine tonality.

6 Conclusion